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INTRODUCTION

The Energy Research and Development Administration has invited respondents to indicate their interest in applying specific technologies to specific oil shale resource types within the Eocene shales of the Green River formation of Colorado, Utah, and Wyoming.

Respondents to PON #2 were allowed to propose a shale oil recovery method that uses existing technology in which case a preliminary study might be followed by a demonstration unit. Other proposers were allowed to extend the state-of-the-art, necessitating sub-scale experimentation prior to demonstration.

In an effort to alleviate the national energy concern, the following objectives were set out:

1. Demonstrate the technical and economic feasibility and environmental costs of shale-oil recovery by true in situ or modified in situ retorting methods.

2. Demonstrate the best fracturing or explosive rubblizing technique for the resource.

3. Determine the operating conditions necessary to obtain the desired retorting results, whether these results be maximum oil production, maximum gas production, or maximum resource recovery.

The National Environmental Policy Act of 1969 requires all agencies of the Federal Government to include a detailed impact statement in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. (Section 102 (2)(C)).

An initial assessment of the environmental impacts of proposed actions are to be undertaken concurrently with initial technical and economic studies and, where required, a draft environmental impact statement prepared and circulated for comment in time to accompany the proposal through the existing agency review processes for such action. (40 CFR 1500.2 (b))

This document has been prepared for the purpose of assessing the environmental impact of the shale oil recovery process proposed for funding by the Geokinetics Oil Shale Group (hereinafter called GSG).

I. DESCRIPTION OF PROPOSED ACTION

The proposed project involves design, construction and operation of a series of retorts and collection of data from an array of instrumentation installed in each retort. The basic rock fragmentation and retort operating problems will be worked out on relatively small retorts that will be 10 to 20 feet wide by 10 to 15 feet thick by 30 to 80 feet long under 10 to 20 feet of overburden. Basic parameters to be varied include width, thickness, and length of retorts and thickness of overburden. Air flow rates and retorting rates will be varied, and various blasting schemes to optimize fragmentation and the distribution of permeability will be investigated. At the end of each retort run the data will be interpreted and evaluated and the design of the next retort and of its method of operation will be improved. As experience is gained, the retorts will be progressively scaled up. When operation of a number of large retorts has been successfully accomplished, the research project will be ended.

The process research and development part of the project is currently under way and is estimated to be completed in October, 1979 and to involve construction and operation of approximately eighteen retorts of progressively increasing size. Construction and operation of three to five commercial demonstration size retorts is estimated to be completed during 1981.

The project is broken up into six phases. The first phase has been completed and Phase II is scheduled for completion by October 31, 1976. At the end of each phase an evaluation of technical progress will be made. Costs of the next phase will then be estimated in detail and operational plans and retort designs refined. A decision will then be made by the participants in the project as to whether or not to proceed to the next phase.

Environmental impacts that will be present as a result of the project are slight topography disturbance, air emission from the excess process gas flare, and possible contamination of ground and surface waters. These impacts and their control will be discussed in more detail in the body of this report.

II. DESCRIPTION OF EXISTING ENVIRONMENT

A. Geology

The project is located in Section 2, Township 14 South, Range 22 East, Uintah County, Utah, which is in the southern portion of the Unitah Basin. This section is a State of Utah school section on which GSG holds an oil shale lease. Bench land topography is predominant in this arid to semi-arid region with the site elevation approximately 6800 feet. The surface of the southern Uintah Basin ascends rather uniformly from an altitude of about 4700 feet above sea level near the confluence of the Green and White Rivers to more than 9000 feet along

the crest of the Roan Plateau to the south. Continuity of this surface is interrupted by deep narrow canyons of the larger tributaries of the Green and White Rivers. The drainage of the project site is by an intermittent stream called Indian Ridge Canyon. The sequential order of drainage is as follows: Indian Ridge Canyon, Sweetwater Canyon, Two Waters Creek, White River and Green River. The location of the project site is shown on map one (1), at the end of this report.

The geology of the region has been studied from the standpoint of its oil and gas production and oil shale reserves. The Unitah Basin is a large synclinal trough formed by the deformation of Tertiary and older rocks. The main axis of the syncline trends generally eastward and lies near Vernal. Thus the rock strata in the southern Uintah Basin, including the project site, dip generally to the north. The GSG section is located on land characterized by the outcrop of the Mahogany oil shale zone. The known mineral resources are oil shale which is at or near the outcrop at the project site, and oil and gas which is found in the Dakota and Mesa Verde formations approximately 7000 and 9000 feet below the surface respectively.

The soils of the region are alluvial type and their depth is shallow, zero to six inches on the bench tops with deeper build ups in the drainage troughs.

Seismicity data indicates the area is an aseismic region. The closest seismic activity recorded was located in the Book Cliffs, 50 to 60 miles southwest of the project site. The highest magnitude recorded has been less than 4.9 on the Ritcher scale.

B. Hydrology and Water Resources

Surface drainage on the project site is intermittent and present as snow melt or runoff from rainstorms. The project site is located on the Indian Ridge Canyon drainage system, but there are no streams or ponds in the area. The quality of this surface water is unknown and will be determined as part of the project.

Little is known of the ground water. During the second phase of work, ground water was occasionally found in test bores into the oil shale. It is not known whether the oil shale is an aquifer or whether this was surface water that was present in fractures in the oil shale. The ground water quality will be studied during the next phase and subsequent phases of the project.

C. Meteorology

From existing literature the climate and meteorology of the specific area is only generally known. The annual precipitation is 8 to 12 inches, which falls as snow in the winter and rain, in the form of thunder showers, in the summer. The average number of days with thunderstorms varies from 40 to 50 per year. Temperatures are moderate, with maximum summer temperatures of above 100°F and winter minimums below 0°F. The number of frost free days is approximately 100 to 110. Gentle westerly winds prevail in the area. The air quality is good with zero to 20 days of high pollution forecast annually.

D. Societal

The region is only sparsely inhabited by ranchers who lease Bureau of Land Management land for grazing. The actual project site was uninhabited prior to commencment of the project. The employees on the site live in a temporary encampment. All personnel maintain a permanent residence elsewhere. The region has never become heavily populated for several reasons: It is too dry to support agricultural use other than low density grazing, land ownership is by state and federal governments, water is poor in quality and in short supply, the area is remote from main routes of travel, and the economics of producing its mineral resources other than oil and gas have been unprofitable.

The nearest community providing services is Vernal, Utah, which is the county seat of Uintah County, and is located about 70 miles north of the project. Vernal was the subject of a population increase in the mid-1960's and is currently fairly stable with a population of approximately 6000.

E. Aesthetic

The general area has aesthetic value in that it has been subjected to very little alteration as a result of human settlement. Sparsely vegetated bench lands, scenic deep narrow canyons, and beautiful sunrises and sunsets are not fully appreciated by the public due to poor accessibility. The primary uses of the land are agricultural (cattle grazing), oil and gas production, and recreational (hunting). GSG's underground retort process, which requires only minimal surface disturbance, should not substantially disrupt the aesthetic value of the region.

F. Historic

No mention has been found in the literature of any known inhabitation period by any human community. It is known that Indians have used this area as a hunting ground from time to time, and that early exploratory travels of the white man traversed the area. Due to the lack of potable water

however, it is doubtful that there was ever any permanent settlement on the GSG plot prior to the project. A few ranchers have grazed cattle on the project section in the past and it is currently under a grazing lease.

GSG has written a letter to the Utah Historical Perservation Office requesting information pertaining to the historic value of the project site. The Utah office is working on the request and this information should be available shortly.

G. Political

Until recently when the potential value of oil shale and oil and gas reserves were discovered, this area was of no political importance. With these discoveries, there has been much political encouragement from county and state officials to develop the oil shale so that the slumping local economy can be bolstered. The State of Utah's Division of Oil, Gas and Mining has been very enthusiastic toward the GSG project, and encouragement has been forthcoming from the Uintah Basin Association of Governments.

H. Economic Environment

The existing economy in the immediate region has been chiefly cattle grazing. Inasmuch as the retorting process has minimal surface impact, the effects on grazing will be insignificant and the project will be an economic plus. The economic impact of this project will reach Vernal where the slumping economy will be benefited. The scope of the project will require employing 5 laborers and 1 skilled crafts above the current number of personnel now employed by GSG. The local employment statistics show a high unemployment rate and local authorities are willing to assist GSG in locating workers for the project. The income levels generated by this project will be comparable to the position and rate of the local market. The hiring practice will be to recruit from the local labor market whenever possible in order to benefit the local economy.

I. Institutional

There is no planned development or specific use of the land in this region by city, state or federal governments. This area is considered too remote for planned development but on the other hand, local and state agencies have encouraged us in our efforts to develop the oil shale resources of the area.

The project site is leased solely for the development of its oil shale resources; grazing and other mineral (oil and gas reserves) rights are retained by others. GSG has made contact with the other lease holders and will work with them in a business-like manner.

Water scarcity will not pose any problem to the project as the process is designed so as to not require the use of any water. Water needed will be for ordinary camp use.

J. Biological Environment

A representative from the State of Utah's Division of Oil, Gas and Mining inspected the existing biological community. The survey found to present the following existing flora: Utah Juniper, Pinion Pine, Sagebrush, Four Wing Salt Brush, Blue Stem Wheat Grass, Cheat Grass and Winter Fat. Revegetation is part of the program and full reclamation of the land will be addressed in accordance to the State's Mining Reclamation Act. Personnel qualified in the field of revegetation will be employed to develope and oversee a revegetation program. The program will be coordinated through the State of Utah's Division of Oil,Gas & Mining, which has the responsibility of overseeing reclamation.

The existing fauna includes several species of birds, small mammals and large game mammals. Crows, hawks, sage grouse, pheasant, doves, rabbits, moles, ground squirrels, bobcat, coyote and mule deer have been sighted in the area. None of the species sighted are on the threatened or endangered species list. The design and scope of the project will cause it to have only minimal impact on the fauna.

K. Facilities

Existing facilities on the site consist of trailers and equipment used during Phases I and II of the project. These facilities are temporary structures used as housing and as a work area for the employees. No permanent installation has been built nor is planned for the site. The employees all maintain permanent residences elsewhere and it is anticipated that nearly all of the new employees will be indigenous people from Vernal. This will minimize the impacts felt both at the site and in Vernal, as employee dependents will already be included in the housing, educational, health, transport, etc. sectors of the Vernal area.

III. DESCRIPTION OF POTENTIAL ENVIRONMENTAL IMPACTS

The overall environmental assessment effort as defined in this section is designed to proceed in phases corresponding to the development and completion of the proposed project.

A. Construction Phase

The project site consists of one section of land located adjacent to a county road which is used primarily by oil field personnel and hunters and that runs south from Ouray. There is an existing access road from the county road into camp, so that the project can proceed without the construction of a new road. The camp housing and working areas are operational and were constructed during the second phase. Therefore, the requirements to maintain the road and camp are all that remain of the construction phase.

Utility sources are not readily available to the site, therefore, power and communications will be provided by diesel generators and a two-way radio, respectively.

In that the project is non-commercial, the plan of attack has been to build and construct on a temporary basis, so that the project impact can be completely reversible to a natural state upon completion.

B. Operational Phase

The operational phase consists of all five major steps: drilling and blasting, re-entry drilling, retort preparation, and air injection tests, burn and recovery, and post burn examination.

1. Effects on Water

There may be some impact on both ground and surface water as a result of the operational phase. The extent of this impact is currently unknown, and one of the objectives of the project is to determine its effects on the local water resources.

During the first and second phases ground water has been infrequently encountered in drill holes. This water is assumed to be saline surface water that accumulated in the hole as a result of seepage, as there is no known aquifer in the oil shale at this shallow depth. However, ground water samples will be analyzed from preblast and post retort drill holes by a certified laboratory for a complete analysis, to include trace elements and organic constituents, to determine the operational effects.

Two complete preblast and post retort samples of both up-dip and down-dip waters will be drawn from holes drilled to the bottom of the shale zone. The reason for two samples is to ensure a representative analysis of the water. Post burn water samples will be taken and analyzed if water is present at that time.

Additional ground water samples will be taken from holes 100 to 200 feet from the retort on the down-dip side in the shale zone. These results may be helpful in determining whether or not an aquifer exists in the oil shale bed.

The effluent water, water withdrawn with the oil, will also require sampling. This water is recovered with the oil from both the production well and exhaust gas recovery system. The oil recovered will be stored in petroleum tanks and the oil and water will separate if left to stand. Dikes will be constructed around the storage tanks as a safety precaution against oil spills and as an added assurance of tight effluent water control. Water will concentrate at the bottom of the storage tank due to its higher specific gravity and will be drawn off into a sealed evaporation pond. The bottom and sides of this pond will be lined with an impermeable membrane so that the effluent water will not seep into the soil. The pond will be constructed large enough to allow for complete evaporation as a means of disposal.

The effluent water will be sampled twice during tank water draw off, first during the initial period and second just prior to shutoff. These samples will undergo the same analysis as the ground water and the results will help determine the potential of effluent water as revegetation water.

The most significant environmental impact of the project may be that on the water. Therefore, one of the main objectives of the experiment is to determine the effects of retorts on the quality and distribution of ground and surface water. Irrigation plots using this water will be studied so as to make beneficial use of the water.

Representative pre retort and post retort ground water and effluent water samples will undergo a complete analysis as described in Appendix A in order to fully evaluate the effects of the process on ground water.

2. Effects on Land

The project site is located on Section 2, Township 14 South, Range 22 East, Uintah County, Utah, which is owned by the State of Utah. This section is located in the southern portion of the Uintah Basin and GSG has a lease on the oil shale mineral rights from the State of Utah. In addition to the map locating the project site relative to Vernal, the exact location of the site relative to the topography of the State section is shown on map two (2), at the end of this report.

The horizontal in situ process may cause minor surface uplift where the overburden is shallow. The State of Utah's Division of Oil, Gas and Mining has received a report that outlined our plans for the project and has granted approval to proceed. Reconstitution and revegetation programs will be coordinated with the Division in accordance with Utah's Mined Land Reclamation Act. The slightly heaved surface will be subjected to accelerated erosion, but the reclamation process will minimize the erosion so that there will not be any long term environmental impacts. In addition to the reconstitution, all pipes and man made materials will be removed from the retort sites.

The existing vegetation has been previously described in Section II, J. The semi-arid region and alluvial soils natively support Pinion and Juniper Pines, Sagebrush and range grasses. Revegetation with native flora will be directed by qualified personnel.

3. Impacts on Air

As stated earlier, the air quality is good with zero to twenty days of high pollution forecast annually. Actually only one source of air pollution is present, but because of different compositions, process gas and flare stack gas will be discussed and treated separately. The process gas is gas recovered from the retort exhaust hole. Production gas then is oxidized in the excess process gas flare and is emitted as flare stack gas.

Process and flare gas will be analyzed as outlined in Appendix B. These analyses will enable us to improve the flare design and operation so as to be in compliance with the emissions parameters (particulates, sulfur oxides, carbon monoxide, photo chemical oxidants, hydrocarbons,

and visible emissions) as specified by the Air Combustion Regulations of the State of Utah, Department of Social Services, Division of Health.

Neither gas streams have been analyzed to date and predictions as to their composition would be guess work, therefore, it is premature to identify pollutants that will pose the most difficult problem to resolve. However, state of the art technology does exist to identify all gas constituents. The flare will then be designed and operated in a manner to meet all state and federal requirements.

The flare stack gas is the only one of the two gases that will be a pollutant. The process gas is transported through piping and process equipment to the flare. The design and construction of the piping process ensures no leakage of this gas into the atmosphere and therefore, the process gas is not considered to be a pollutant. The flare stack gas will contain compounds that are adverse to the good air quality of the region, but the emissions will meet environmental specifications. Due to the small scale and good operation of the flare the long term environmental effects will be negligible. Additional monitoring will be conducted to construct a dispersion model from the stack emissions.

4. Meteorology

A complete ground weather station to monitor and record physical meteorological data will be established in order to tabulate a weather history of the site. Data to be collected include minimum and maximum daily temperatures, wind magnitude and direction at 10 meters above the ground, relative humidity, precipation, and barometric pressure. This weather information will be recorded daily and will be quite valuable to government agencies in developing an understanding of weather patterns in the plateau region.

In later project phases, meteorological stations will be established to obtain data for dispersion modeling and upper air inversion patterns for the general area.

5. Socio-economic Impacts

It is anticipated that up to 20 personnel will be employed for this research project and temporary living quarters in the form of a field camp will be provided for them. The employees from the existing Vernal labor force will fill most positions and their dependents will live in Vernal. This should cause only beneficial impacts because the employees are indigenous to the area and the schools, services, roads, etc. have allowed for their needs. No influx of personnel is anticipated and the employment of these indigenous people will help bolster the sagging economy in Vernal.

The temporary camp is provided only for employees, and dependents will be expected to reside in town. The camp is divided into two areas, one provided for sleeping, eating, and recreation which will be herein referred to as the living quarters, and the other as the job site.

The living quarters consist of several house trailers, and a room with bed and a place for personal effects is provided for each employee. An allowance for three balanced meals, and facilities for cooking and dining will be provided. Sufficient rations are maintained to feed sixteen people for five days in case of isolations due to weather or some other unforeseeable reason. Potable water for drinking and personal hygiene are trucked to camp on an as required basis and provided at a separate facility with access conveniently located to all trailers.

Employees are never completely isolated because a radio with two-way communication to Vernal is maintained and a vehicle will be available as long as one employee is on the site. Power for lighting, domestic use and work equipment is provided by diesel generators. Recreational facilities will be available to employees after working hours. Sanitation facilities in the form of privies will be located for the convenience of the camp personnel and will be constructed to comply with state requirements.

The job site consists of two trailers, office and warehouse trailers which are located separate from the living quarters. The supply of gasoline and diesel fuel is serviced and maintained by a supplier from Vernal and is located a safe distance from both the living quarters and job site.

The long term socio-economic impacts of this project are minimal. The impact of employing indigenous personnel is beneficial to the sagging economy of the community. The physical impact of the camp is negligible in that after the project, trailers and equipment will be removed and the site will be reclaimed.

6. Occupational Safety

The working environment of this project may be compared with the petroleum industry, and the safety standards observed and the program conducted will closely resemble those of the petroleum industry. This comparison is made to point out the general type of hazards to be dealt with and the generally good safety record enjoyed by the petroleum industry. Engineers, contract specialists, skilled technicans, and laborers will be required for the field work and good safe workmanlike practices will be required from them. Equipment and machinery will be maintained in proper condition, personnel will be required to wear proper protective clothing and gear, and safety standards and regulations will be complied with. For tasks requiring highly skilled work only qualified experienced personnel will be utilized. Examples of these tasks are blasting and burning of the retorts, which will also be fenced in as a precaution. H_2S and other noxious gases will be monitored during retort burns and oil recovery operations. First aid equipment and supplies will be properly maintained and an emergency evacuation method will be established.

Fire safety first requires a good fire prevention program. This is already in effect at the project site. The nearest fire district is in Vernal, therefore, in house capabilities are required for the protection of personnel and equipment. Camp and work areas will be maintained in a clean and orderly manner. Fire extinguishers will be located and maintained in all trailers, at the fuel tanks and within easy access to all work areas. Potable water is available to fight fires if necessary, but, in that water is at a premium, it will not be used as a first line of defense.

The disposal of solid waste will be in accordance with the State of Utah Department of Social Services, Division of Health's Code of Solid Waste Disposal Regulations. Construction and operation of a camp disposal site requires Utah State Board approval, which is being arranged for.

7. Health Effects

The specific objectives of the proposed experiments are dual in nature. Simple short-term exposure screening tests will be implemented initially to assess general toxic properties of the test material or to plan more extensive research studies. This approach will provide meaningful toxicity data with a minimum expenditure of time and resources. The screening tests will be followed, as appropriate, by both intermediate-term and long-term exposure experiments designed to provide detailed information on the toxic materials. These experiments will assess dose-response relationships, determine the physiologic and biologic sites of activity, and carefully characterize the nature of the toxicity.

The information derived from the studies will be of primary importance in assessing conditions or materials which represent potential health hazards for humans, and the severity of the identified health hazards. Funding for this study will be an obligation of the GSG Project.

C. Post Operation Impacts

Core holes and/or excavation techniques will be used to determine the recovery efficiency in the various zones of the retorts. Different methods of examination will be attempted in order to develop techniques to enable us to diagnose the results of the experiments. The spent shale will be analyzed to determine the effect of retorting on the shale properties as well as the percent of extraction, as outlined in Appendix C. The core holes and/or excavations will be fenced off and left open only as long as any post examination information is being acquired. Then the core holes and/or excavations will be backfilled using the removed material as fill. The revegetation will follow to complete the reclamation of the surface of the retorts. The reclamation and revegetation will be directed by qualified personnel in accordance with the State of Utah's Mined Land Reclamation Act and coordinated through the Division of Oil, Gas and Mining.

After the retort burn is completed, air injection is stopped and temperatures will be monitored as the subsurface rock cools. The rate of cooling of the rock after the burn has been extinguished will be monitored in order to predict future results. Surface water may seep into the retort and occupy its voids and this phenomenon will be investigated during the post burn analysis.

IV. MITIGATION

A. Water

All effluent water will be contained in a membrane-lined evaporation pond. There will be no drainage from this pond and only small amounts of water will be removed to study the possibilities for its use as irrigation water for revegetation. The method of discharge will be through solar evaporation.

The ground water will be studied throughout the project to determine the effects of retorting and to locate aquifer communication if present. Core holes will be drilled into the oil shale section down dip from the retorts in order to determine if effluents from the retorts are migrating with ground waters.

B. Oil

All oil recovered from the retort will be collected in storage tanks. Oil removed from the retort will be transported through a completely enclosed system of piping and process equipment and stored in standard petroleum storage tanks. Dikes will be built around the storage tanks as a precaution against oil and effluent water spills. Oil will be removed from the site by tank truck.

C. Air

The flare will be operated during the burn as a means to safely dispose of the excess process gas. The process equipment will be of air tight construction and the retort will be monitored for gas leaks. Federal and state air emission standards will be complied with.

Dust from the roads and disturbed areas of the project site will be controlled by compaction and by wetting down with water. The surface of the retorts is normally compacted as part of the retort construction and dust has not been a problem.

D. Fire

In consideration of the remoteness of the project site, in house fire prevention measures are in effect and fire fighting equipment is on hand and properly maintained.

E. Socio-economics

GSG has and will provide employees with more than adequate living accomodations to ensure comfort, health and convenience. As stated earlier, housing accomodations are provided for the employees in the field camp. The employment of indigenous personnel will avoid adverse community impact and benefit the sagging economy. Emergency first aid facilities will be provided for the employees at the project site.

V. ALTERNATIVES

Possible alternatives do exist but they also pose potential problems. One alternative would be to relocate the project to another site with similar geologic characteristics. Other possible project sites are located in similar surroundings and the environmental effects of the project would be transferred and duplicated at the alternate site, thus doubling the total environmental effects of the project.

Alternative number two might be to relocate the project at a site with thicker overburden. Operating under thicker overburden would require underground mining operations and would therefore, have a somewhat greater impact on the environment as the mined rock would have to be disposed of in some manner.

The third alternative might be to confine the work to models. This work has been done in GSG's labs over the past three years and now requires scaling up to the field size retorts to accomplish further meaningful technical progress in development of the process.

In view of the alternatives, the proposed project is felt to be the best choice.

VI. REPORTING

An observer from the Laramie Energy Research Center will be appointed to this project and joint reports will be prepared by GSG and Energy Research and Development Administration representatives. These reports will include technical and environmental data and interpretations and will be written on a quarterly basis.

APPENDIX A

WATER ANALYSIS

Pre and post retort ground and surface waters will be analyzed as follows:

1. Physical Characteristics

temperature	turbidity
pH	chemical oxygen demand
specific gravity	total organic carbon
conductivity	dissolved organic carbon
gross alpha	total suspended solids
gross beta	total dissolved solids

2. Trace Elements

Lithium	Li	Cyanide	CN	Stronium	Sr
Beryllium	Be	Titanium	Ti	Zirconium	Zr
Flourine	F	Vanadium	V	Molybdenium	Mo
Sodium	Na	Chronium	Cr	Silver	Ag
Magnesium	Mg	Manganese	Mn	Cadmium	Cd
Aluminimum	Al	Iron	Fe	Barium	Ba
Silica	Si	Nickel	Ni	Platimum	Pt
Phosphorus	P	Copper	Cu	Gold	Au
Sulfur	S	Zinc	Zn	Mercury	Hg
Chlorine	Cl	Arsenic	As	Lead	Pb
Potassium	K	Selenium	Se	Boron	B
Calcium	Ca	Bromine	Br		

3. Anion Compounds

Nitrites/Nitrates
Ammonia
Sulfates
Carbonate/Bicarbonates

4. Organic Trace from Water Separations

Methane
Ethane
Propane
Butanes
Pentanes
Hextanes and higher

5. Organic Characterization

Amines
Alkanes
Alkenes
Hydroaromatic
Polycyclic aromatics
Sulfides

APPENDIX B

AIR ANALYSIS

Air analysis will be conducted in two ways. The stack gas which affects the air quality will be analyzed, as well as the process gas which is flared to form the stack gas.

1. Process Gas Analysis

   a. General Characteristics

      Temperature
      Specific Gravity
      Heat Value

   b. Trace Elements

Antimony	Sb	Lead	Pb
Arsenic	As	Lithium	Li
Boron	B	Mercury	Hg
Beryllium	Be	Molybdenum	Mo
Cadmium	Cd	Nickel	Ni
Cobalt	Co	Phosphorus	P
Chromium	Cr	Selemium	Se
Copper	Ca	Silver	Ag
Flouride	F	Vanadium	V
Iron	Fe	Zinc	Zn

   c. Common Gases

Sulfur Dioxide	SO_2	Ozone	O_3
Hydrogen Sulfide	H_2S	Nitric Oxides	NO, NO_x
Carbon Monoxide	CO	Elemental Gases	O_2, CO_2, N_2
Total Hydrocarbon	C_1-C_6		

   d. Characterization of Gases

      Trace Organics - Organometallics

      Major Organic Compounds

2. Stack Gas Analysis

a. General Characteristics

Temperature
Gas Flow Rate- Stack Velocity
Wind Speed and Direction
Particulates (quantity and sizing)

b. Characterization of Stck Emissions

Sulfur Oxides	SO_2, SO_3
Nitrogen Oxides	No, NO_2
Carbon Monoxides	CO
Ozone	O_3
Carbon Dioxide	CO_2
Water	H_2O
Elemental Gases	N_2, O_2, Ar
Total Hydrocarbons	C_1 - C_6

c. Solid and Particulate Trace Analysis

Antimony	Sb	Molybdenum	Mo
Boron	B	Nickel	Ni
Beryllium	Be	Phosphorus	P
Arsenic	As	Tellurium	Te
Cadmium	Cd	Thorium	Th
Iron	Fe	Silver	Ag
Lead	Pb	Selenium	Se
Mercury	Hg	Zinc	Zn
Vanadium	V	Chronium	Cr

d. Dispersion modeling to predict area of influence.

APPENDIX C

OIL SHALE RESIDUES

Retorted shale analyses to include:

1. Trace elements

Arsenic	As	Lithium	Li
Boron	B	Mercury	Hg
Beryllium	Be	Molyberum	Mo
Cadmium	Cd	Antimony	Sb
Cobalt	Co	Nickel	Ni
Chromium	Cr	Selenium	Se
Copper	Cu	Thorium	Th
Flourine	F	Uranium	U
Iron	Fe	Vanadium	V
Lead	Pb	Zinc	Zn

2. Analysis for Potential Toxicants

   Pyridine
   Pyroles
   Polynuclear Hydrocarbons

3. General Characteristics

   Specific Gravity
   Fischer Assay